

lutosum (HOUBRICK, 1973) from Florida produce spawn belonging to this group, while *C. lutosum* from Santa Marta produces meandering spawn ribbons, and other species of this genus secrete filamentous egg masses.

4. Group of *Cerithium lutosum*

Egg masses in the group of *Cerithium lutosum* consist of gelatinous egg ribbons arranged into regular loops containing single egg capsules. Each embryo hatches as a crawling young. Surprisingly, spawn of *C. lutosum* (identifications of material made by R. S. Houbrick, Washington, D. C.) from Santa Marta is very similar to that of *C. muscarum* Say, 1832 from Florida and rather different from *C. lutosum* spawn from there (HOUBRICK, 1973, 1974). The small egg mass of the pyramidellid *Cingulina babylonica* differs from this general type of spawn only in possessing oval egg capsules.

5. Group of *Turritella variegata*

The spawn in the group of *Turritella variegata* consists of single egg capsules containing a number of embryos. These egg capsules are surrounded by a mucus cover which is agglutinated with sediment particles. The whole egg mass consists of numerous capsules. In the case of *Turritella variegata* and *T. communis* (LEBOUR, 1933, 1937; THORSON, 1946) they exhibit a peduncle on each egg capsule uniting the capsules to bundles which, through an elastic ribbon, are connected to each other, giving the egg mass an appearance resembling a bunch of grapes. This elastic ribbon also anchors the mass to the substrate.

Scala clathrus Linnaeus, 1758 (VESTERGAARD, 1935) produces spawn related to that of *Turritella* in its shape. Here single agglutinated egg capsules are attached directly to a common central ribbon anchoring the whole egg mass to the substrate. In *Epitonium lamellosum* the round agglutinated egg capsules also form bundles but attachment of each capsule to the median string is achieved by a number of clear threads instead of one peduncle as in *Turritella*. The general appearance of the entire egg mass of *Epitonium* very much resembles that of *Turritella*.

6. Group of *Ampullarius porphyrostomus*

Ampullarius porphyrostomus and *A. monticolus* secrete soft egg masses which in a short time harden into stiff, durable structures. Strauch (in a talk given in the fall of 1973) was able to show that the walls of each capsule of *Ampullarius* include, in addition to organic mucoid material, calcium carbonate which crystallizes in the shape of small cuboid calcite crystals. The mucoid material dries

within a short time when both species have deposited their egg masses outside of the water. This material provides a hard shelter as protection of the developing embryo. Except for the calcite crystals, the egg mass very much resembles that of *Marisa cornuarietis*, which produces spawn attached below the water surface. If the spawn of *Ampullarius* is dropped into water it becomes gelatinous due to the softening of the dried mucoid material and will disintegrate within a short time until all egg cases are unattached to each other.

Other members of the genus *Ampullarius* produce the same type of spawn as do *A. porphyrostomus* and *A. monticolus* (LAMY, 1928).

7. Group of *Cerithium litteratum*

Small narrow tubes irregularly coiled into egg ribbons attached in a regular or irregular manner to hard substrates and with small veligers hatching have been described from a large number of species of *Cerithium*; *C. litteratum* from Florida produces the same type of spawn as found in Santa Marta (D'ASARO, 1970); *C. atratum* from Brasil (MARCUS & MARCUS, 1964) and from Florida (HOUBRICK, 1974) also produce spawn like those of Santa Marta. Egg masses of other members of the genus *Cerithium* from the western Atlantic belonging in this group are described in detail by HOUBRICK (*op. cit.*) who also discusses earlier descriptions of other authors.

The spawn of the genera *Clava* (OSTERGAARD, 1950), *Proclava* (AMIO, 1963), *Cerithidea* (AMIO, *op. cit.*) and *Cerithium* (NATARAJAN, 1958; WOLFSON, 1969) from the Pacific belong in this group. *Cerithium vulgatum* Bruguière, 1789 from the Mediterranean Sea and from the Canary Islands produce spawn quite like that of *C. litteratum* as my own observations indicated and as briefly described by THIRIOT-QUIÉVREUX (1969).

8. Group of *Alaba incerta*

The group of *Alaba incerta* is characterized by flattened, rounded gelatinous egg ribbons attached firmly in spirals to the hard substrate. Each of the numerous eggs is surrounded by a separate spherical egg case. The young hatch as small veligers. LEBOUR (1936) described the flat, slimy spiral coils of *Bittium reticulatum* (Da Costa, 1778) from England. Spawn produced by individuals of this species from the Canary Islands and the Mediterranean Sea look just like that (own observations) and just like that of *Alaba incerta*. Other authors have seen and described the spawn of *B. reticulatum* also (MEYER & MÖBIUS, 1892; LO BIANCO, 1888; ANKEL, 1936; THORSON, 1946; FRETTER & GRAHAM, 1962). Perhaps the

spawn of *Litiopa melanostoma* Rang, 1829 described by LEBOUR (1945) as a flat gelatinous mass of round appearance is actually a coil with the spiral whorls touching each other with their rims, thus giving the appearance of one continuous mass. The same holds true for the spawn of *Australaba* which is described by HABE (1960) as a narrow gelatinous spiral coiled 4 times clockwise and is figured by AMIO (1963) as, in outline, a round egg mass without spiral appearance.

9. Group of *Modulus modulus*

Egg masses of *Modulus modulus* and *M. carchedonius* are characterized by consisting of a tube formed by a gelatinous sheet containing eggs arranged in rows. The hatching young of both species from Santa Marta are small veligers. LEBOUR (1945) found veligers hatching from spawn produced by *M. modulus* from Bermuda; these veligers were close to the conclusion of their metamorphosis. Here only 40 eggs are observed in one mass and veligers will remain inside the egg mass until they have secreted a shell with $2\frac{1}{2}$ whorls.

The type of spawn described here, consisting of a hollow tube, is so far only known from the 2 species mentioned.

10. Group of *Architectonica nobilis*

In this group, producing soft tube-like looped egg masses consisting of egg cases connected to each other by a thread and incorporated in a gelatinous mass, so far only *Architectonica nobilis* can be included. No similar egg mass anchored with additional mucoid roots in soft bottom is as yet known from prosobranchs. *Heliacis* produces an U-shaped jelly mass attached with mucous threads to *Zoanthiniaria* colonies (ROBERTSON, 1967). Egg cases connected to each other by a thread are produced by another architectonicid, *Philippia radiata* Röding, 1798 which attaches its gelatinous egg mass to the umbilicus of its own shell (ROBERTSON, 1970). In addition to spawn from architectonicids, such connections between egg capsules were described from the pyramidellid *Brachystomia* (RASMUSSEN, 1944, 1951; THORSON, 1946) and the marine pulmonates *Siphonaria* (VOSS, 1959) and *Trimusculus* (HAVEN, 1973).

11. Group of *Petalconchus mcgintyi*

The shape of the capsules of the group of *Petalconchus mcgintyi* and that of the following 2 groups is quite similar and only their modes of attachment differentiate

them clearly one from the other. Members of this group produce capsules that are attached singly with their peduncles to the inside shell of the tube of the female. One spawn mass within the shell of the mother animal usually consists of quite a number of capsules showing different degrees of development each.

Besides in *Petalconchus erectus* and *P. mcgintyi*, such spawn exists also in the vermetid genera *Lemintina* (LAMMY, 1928), *Serpulorbis* (HABE, 1953), and *Bivona* (own observation). Development of the embryos varies from hatching as veligers, as veliconcha, or as crawling young.

12. Group of *Crepidula convexa*

The group of spawn morphologies similar to that of *Crepidula convexa* is characterized by simple capsules attached by one common base, where all peduncles of one egg mass are fused. Its location of attachment is on the substrate under the slipper shell of the female. Spawn of one egg mass is of about the same age and produced in one continuous spawning act. Quite a number of species is known to have egg capsules of this type. They belong to the genera *Calyptraea*, *Crepidula*, *Crucibulum* and *Amalthea*. The latter genus includes species with this type of capsules (HABE, 1953) and species where the capsules are attached to the tissue of the female (THORSON, 1940) as is typical for the group of *Cheilea equestris* (see next group). Perhaps this indicates some confusion within the genus *Amalthea* which seems to include species belonging partly to the Calyptraeacea and partly to the Hipponiceacea.

Development of embryos within the capsules of this group, known from the literature, reflects the same situation as was found for the Caribbean species. In addition to *Crucibulum* from Santa Marta with veliconcha hatching, Persian Gulf members of this genus hatch as veligers (THORSON, 1940). Representative of *Calyptraea* from Santa Marta and the Persian Gulf (THORSON, *op. cit.*) hatch as veligers, while the European species hatch crawling (FRETTER & GRAHAM, 1962). Many members of the genus *Crepidula* (COE, 1949; HABE, 1953; THORSON, *op. cit.*) hatch as veligers while just as many hatch as veliconcha or crawling young (COE, *op. cit.*; DEHNEL, 1955; KNUDSEN, 1950; MORITZ, 1939; WERNER, 1955).

13. Group of *Cheilea equestris*

Capsules in the group of *Cheilea equestris* are attached to the tissue of the female. Other than that the shape of the capsules is quite the same as was seen in the 2 preceding groups. Each spawn consists of a number of capsules pro-

duced in one spawning act. As mentioned before, the genus *Amalthea* includes species with egg masses belonging to the group of *Crepidula convexa* and to the present group. Besides that, only members of the genera *Cheilea* and *Hipponix* (CERNOHORSKY, 1968; LAWS, 1970; RISBEC, 1935) produce spawn of this type. From spawn of the genera *Amalthea* (THORSON, 1940), *Hipponix* (CERNOHORSKY, *op. cit.*) and *Cheilea* veligers hatch, while in other members of the genus *Hipponix* (LAWS, *op. cit.*; THORSON, *op. cit.*) crawling young leave their egg capsules.

With 4 additional groups the spawn morphologies of lower mesogastropods known from the literature could be completed. Many members of the genera *Littorina*, *Nodilittorina*, *Echininus* and *Tectarius* of the Littorinidae produce pelagic egg capsules (BANDEL, 1974b; see there for additional literature). They would comprise the first of the 4 additional groups.

Shallow cupolas or hemispheres of transparent capsules attached to all kinds of substrates are produced by many species of the Rissoacea (LEBOUR, 1936, 1937; FRETTER, 1948; FRETTER & GRAHAM, 1962; and others). Here some contain only one egg, others many. Connections to capsule shape as found in the group of *Caccum antillarum* with one egg per capsule or like those of *Hydrobia ulvae* with many eggs per capsule are close, and intergrading forms are known.

The third additional group could be seen represented by the spawn of *Bittium varium* (Pfeiffer, 1840) described by MARCUS & MARCUS (1962). Here egg capsules are connected to each other by a thread common to all from which threads branch off holding a capsule each at their ends.

The fourth and last additional group may be seen in the unattached sausage-like capsules of *Capulus hungaricus* (Linnaeus, 1758) which are held, one per female at one time, in a fold of the propodium of the mother under the protective cover of the limpet-shell (LO BIANCO, 1888; ANKEL, 1937; THORSON, 1946; FRETTER & GRAHAM, 1962). These capsules, in contrast to those of the groups of *Petalococonchus mcgintyi*, *Crepidula convexa* and *Cheilea equestris* do not have peduncles.

The morphology of spawn and egg capsules in higher Mesogastropoda (BANDEL, 1975, in press), with the exception of those of the Strombacea, is quite different from almost all groups mentioned here, with the exception of the cupola-shaped capsules of the Rissoacea which are

encountered in similar shape in many quite unrelated taxonomic of the Neogastropoda as well (BANDEL, in press).

Some species of the Archaeogastropoda belonging to the superfamilies Pleurotomariacea, Patellacea and Trochacea, as indicated by my own observations, produce egg masses resembling those of many of the groups here differentiated, consisting of gelatinous spiral or looping ribbons or strings. The same holds true for opisthobranch egg masses (HURST, 1967; see there for more literature; own observations). Especially spawns consisting of gelatinous ribbons and strings and also of sac-like shapes are common in different representatives of the opisthobranchs. Marine pulmonates (HAVEN, 1973; VOSS, 1959), as well as many aquatic freshwater pulmonates produce spawn similar to that described in the group of *Marisa cornuarietis*.

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The Genus *Cerberilla* of Japan

(Nudibranchia : Eolidoidea : Aeolidiidae)

with the Description of a New Species

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(1 Plate; 10 Text figures)

THE WORLD SPECIES of *Cerberilla* have received particular attention from a number of recent workers (TARDY, 1965; BURN, 1966, 1974; COLLIER & FARMER, 1964; and McDONALD & NYBAKKEN, 1975), because of their unusual habits of burrowing into the submarine substratum and feeding on some actinians living in the same habitat as the predator (TARDY, *op. cit.*; McDONALD & NYBAKKEN, *op. cit.*). The present paper gives accounts of the 3 species of *Cerberilla* from Japan. Of these, one is regarded as new to science. The material on which my study was based came from different sources shown separately under the subject of each species.

1. *Cerberilla asamusiensis* Baba, 1940

(Japanese name: Kasumi-minoumiushi)

(Figures 1, 2)

Synonymy:

Cerberilla asamusiensis BABA, 1940: 108 - 111; text figs. 9 - 10.
— Asamushi, Mutsu Bay; BABA, 1957: 9 (list)

Distribution: Pacific coast of Japan from N to S: Asamushi, Mutsu Bay (the type locality); various stations of Sagami Bay (collectors: the Biological Laboratory of the Imperial Household, and Mr. T. Akiba); and Tomioka, Amakusa (collector: Dr. T. Kikuchi).

Main Material Examined: One specimen collected by Mr. T. Akiba from Kariyagasaki near Nagai, Sagami Bay, July 11, 1971.

The main features of the body colors in the type of *Cerberilla asamusiensis* were re-established by Mr. Aki-

ba on his specimen collected from Sagami Bay. According to him, there occurs a black line running transversely along the anterior border of the head to the bases of the oral tentacles. An additional black line is present at each side of the rhinophores which are black to the tip when seen from the rear. Each branchial papilla has a black spot down the apex on the outer (= upper) surface. Often this spot is accompanied with a yellow marking situated below it. The head above, and the anterior margin of the foot are tinted yellow. The bare space of the back is slightly dark. The general integument of the rest of the body is colorless. The living animal measured about 22 mm in length.

The branchial papillae are arranged in simple oblique rows on either side. They number up to 16 in the largest rows. The genital orifices lie immediately below the 3rd right row. The protruded penis appears to be bluntly conical, and unarmed. The anus opens below the 6th right row, and thus it is seemingly pleuroproctic in position.

The jaw edge is smooth. The radular formula is $18 \times 0.1 \cdot 0$. The teeth are colorless. Each tooth is typically pectinated with about 7 major denticles on either side of the median notch, of which the marginal or submarginal ones are the longest. In the median part of the tooth there occur accessory denticles between the major ones.

Remarks: Obviously *Cerberilla asamusiensis* is closely allied to *C. ambonensis* Bergh, 1905 (from Amboina) and *C. bernadettae* Tardy, 1965 (from the Atlantic coast of France) in the presence of a black spot on each branchial papilla, and in the general shape of the radular teeth (see also BURN, 1974: 55; and McDONALD & NYBAKKEN, 1975: 381). But it is noticeable at least that the accessory denticles possessed by each tooth are scanty in number in *C. ambonensis* or missing altogether in *C. bernadettae*, and

these are fairly well developed in *C. asamusiensis*. A further discussion concerning the relationship of these 3 species is to be made in the future.

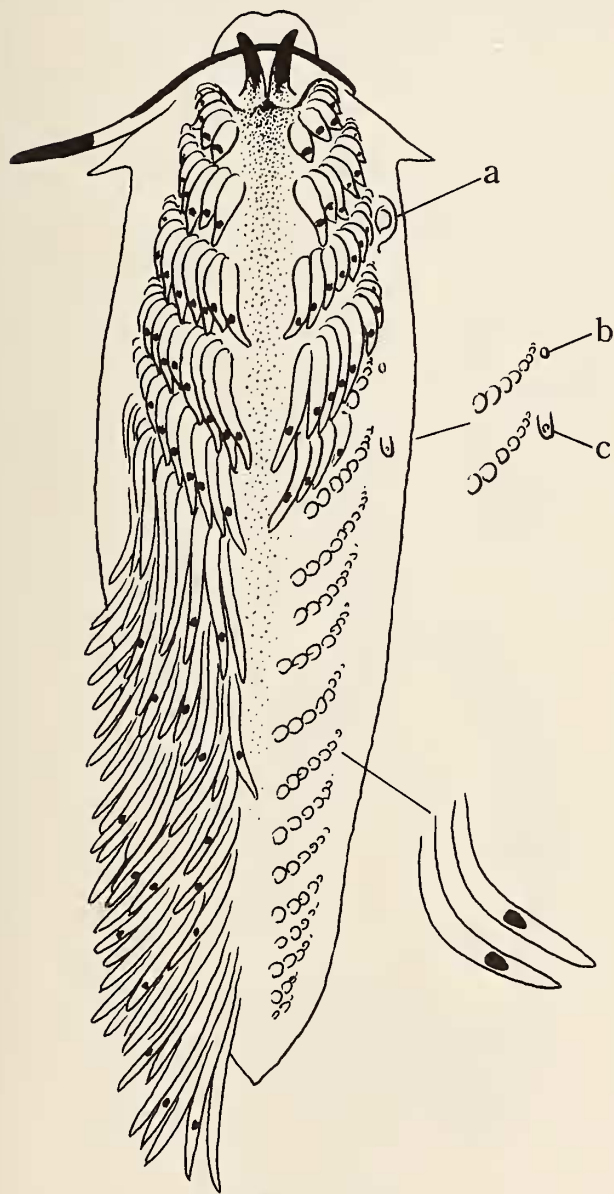


Figure 1

Cerberilla asamusiensis Baba, 1940
from Kariyagasaki near Nagai, Sagami Bay
Preserved animal, collected on July 11, 1971; length 20 mm; the
oral tentacle on the right is missing
a - genital orifices b - nephroproct c - anus

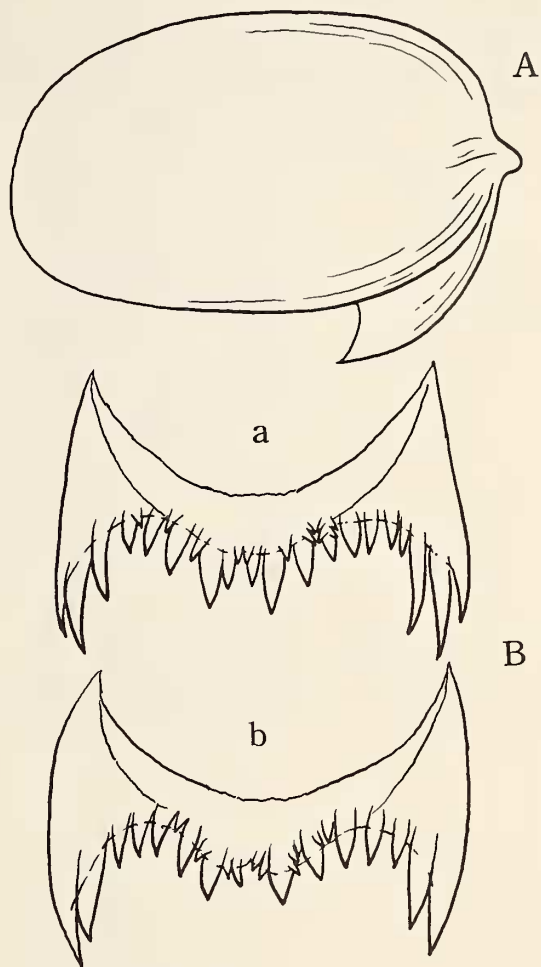


Figure 2

Cerberilla asamusiensis Baba, 1940
The mouth parts of the same animal

A: Right jaw plate $\times 15$
B: Teeth (a, b) from the middle of the radular ribbon $\times 90$

2. *Cerberilla longibranchus* (Volodchenko, 1941)

(Japanese name: Nippon-kasumi-minoumushi)

(Figures 3 to 6)

Synonymy:

Aeolis longibranchus VOLODCHENKO, 1941: 59, 67; plt. 3, fig. 5; plt. 4, fig. 5. — Japan Sea

Distribution: Japan Sea (the type locality); and the Pacific coast of middle Japan (see below).

Material Examined: One specimen collected by Dr. H. Utinomi from Hatakejima near Seto, Kii, April 11, 1952;

and 2 specimens collected by Dr. A. Inaba from Mukai-shima, the Inland Sea of Seto, January 16 and 17, 1961.

The animal from Seto was observed in a preserved state. It measures about 15 mm in length. The body form

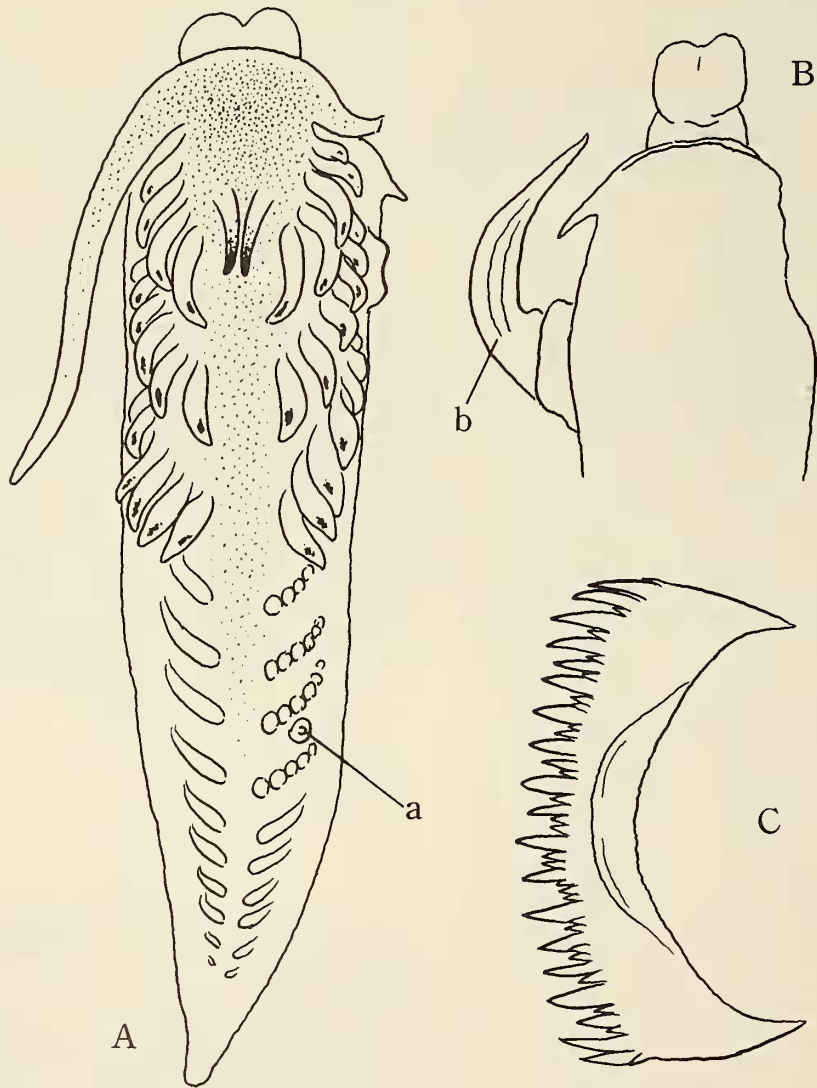


Figure 3

Cerberilla longibranchus (Volodchenko, 1941)
from Seto, Kii (April 11, 1952)

A: Preserved animal from dorsal side, length 15 mm; the oral tentacle on the right is missing

B: The same animal from the ventral side

C: Tooth from the middle of the radular ribbon

a - anus

× 130
b - penis

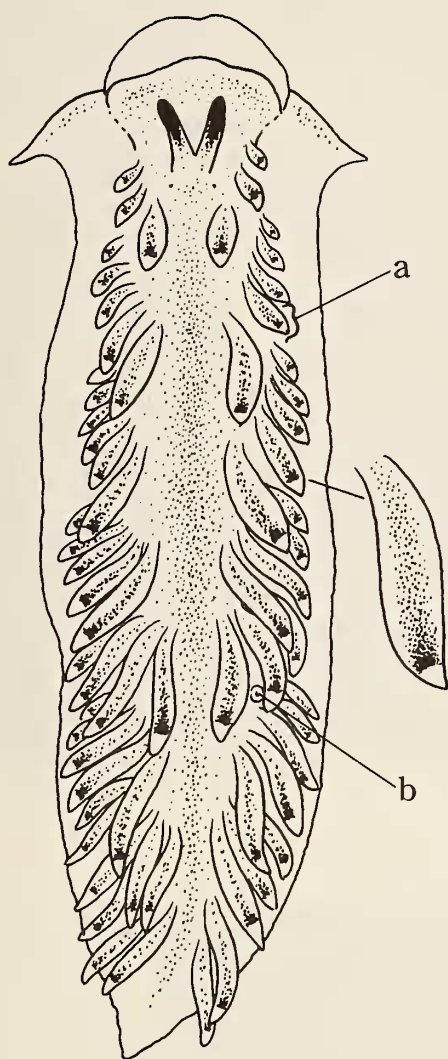


Figure 4

Cerberilla longibranchus (Volodchenko, 1941)
from Mukaishima, the Inland Sea of Seto

Living animal, collected on January 17, 1961; length 18mm; the
tentacle on either side is missing

a - genital orifices

b - anus

is typical of the genus *Cerberilla*. The branchial papillae on the back margins are arranged in simple oblique rows, and number 6 to 7 in the largest rows. The genital orifices open below the 2nd row on the right side. The protruded penis is long, lanceolate and unarmed. The cleioproctic anus is situated far back, being found between the 6th and 7th rows of the right side. The head, the bare space

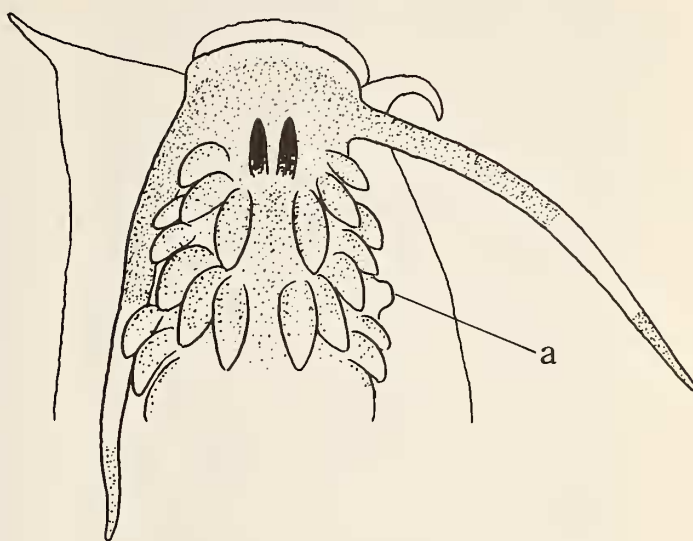


Figure 5

Cerberilla longibranchus (Volodchenko, 1941)
from Mukaishima, the Inland Sea of Seto

Head region of the living animal, collected on January 16, 1961,
as drawn by Dr. A. Inaba

a - genital orifices

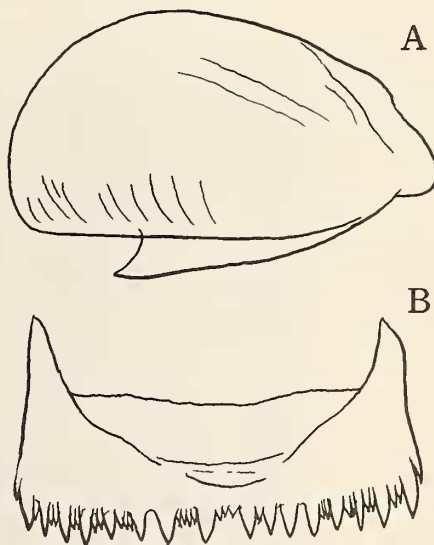


Figure 6

Cerberilla longibranchus (Volodchenko, 1941)

The mouth parts of the same animal as drawn by Dr. A. Inaba

A: Right jaw plate $\times 25$

B: Tooth $\times 75$

of the back, and the oral tentacles are dark brown. The rhinophores are black above. Each branchial papilla is also black towards the tip on the outer surface. The general color of the rest of the body is whitish. The jaw edge is unarmed. The radular formula is $16 \times 0.1 \cdot 0$. Each tooth, slightly yellowish in color, is broadly rectangular, and provided with a row of 8 to 9 denticles on either side of the median emargination. All these denticles are short, not increasing in length towards either margin. One to 2 accessory denticles stand between most of the major ones.

The animals from Mukaishima were studied while each was alive. The length of the larger one was 22 mm, and that of the smaller one was 18 mm. The coloration of the body is rather simple. The general integument including the head, bare space of the back, sides and oral tentacles is shaded with dark brown. The rhinophores are more deeply colored dark (or they appear blackish near the tip). On the outer surface of the branchial papillae the dark brown color of their lower half acquires an intensive darkness (or almost blackish tint) towards the tip, which, in turn, is opaque white. The inner surface of the papillae is whitish; the sole is slightly yellowish white. According to Dr. Inaba's examination of one of his specimens, the radular formula is $13 \times 0.1 \cdot 0$. Each tooth is broadly rectangular, and denticulated almost as shown for that of the specimen from Seto. The jaw plate has a smooth cutting edge.

Remarks: *Aeolis longibranchus* of VOLODCHENKO (1941) was rediscovered, and justifiably identified as belonging to the genus *Cerberilla* (see also BURN, 1966: 28). The broadly rectangular shape of the radular teeth is characteristic for this species. The major denticles on the straight anterior border are nearly similar in their length. *Cerberilla longibranchus* differs from *C. asamusensis* in the absence of a black line on the anterior borders of the head and paired oral tentacles, and a yellow spot on the outer surface of the individual branchial papillae.

3. *Cerberilla albopunctata* Baba, spec. nov.

(Japanese name: Hanmyo-kasumi-minoumiushi)

(Figures 7 to 9, 10 to 13)

Distribution: Pacific coast of middle and southern Japan (see below).

Material Examined: One specimen (paratype No. 2) collected by Dr. M. Sugiyama from Sugashima near Toba, Shima, June 4, 1943; 1 specimen (paratype No. 1) collected by Dr. A. Inaba from Mukaishima, the Inland Sea of Seto, March 29, 1964; and 1 specimen (holotype) collected by Mr. A. Doi from Tomioka, Amakusa, May 22, 1974. A colored figure of this species prepared by Dr. M. Horikoshi at Misaki, Sagami Bay on June 18, 1954 was referred to by me.

Holotype: The holotype measures about 27 mm in the living state. The branchial papillae are arranged in simple oblique rows on either side; they are rather flattened and non-caducous, and number 12 to 13 in the largest rows. The genital orifices open below the 2nd row on the right side. The anus is cleioproctic, and visible between the 5th and 6th rows on the same side (such is the case in the paratype No. 2, but in the paratype No. 1 the anus lies between and below the 5th and 6th rows, and thus it is pleuroproctic). The nephroproct is located a short distance in front of the anus.

Coloration: The coloration of the body is very complicated. The general integument comprising the head, bare space of the back and upper sides of the foot, is blackish covered closely with white spots (or patches) of various sizes and different shapes. Across the anterior edge of the head there runs a black line which extends to the lower part of the oral tentacles on either side. The rhinophores are blackish with white tips. Also there occur some spots of white on their body. The head above has 2 pairs of

Explanation of Figures 7 to 9

Cerberilla albopunctata Baba, spec. nov.
from Tomioka, Amakusa

Holotype, collected on May 22, 1974; length 27 mm

Figure 7: Crawling position on the black background

Figure 8: Crawling position on the sandy-mud substratum, showing the protective coloration of the animal

Figure 9: Burrowing position into the sandy-mud substratum